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ABSTRACT

A sorting-recall procedure was used to investigate how long-term memory in elderly subjects is affected by categorical organization. Sixty-four young adults (average age 20 years) and retirees (average age 67) sorted 48 unrelated words into two, four, six, or eight categories prior to recall. High- and low-frequency lists were tested, a manipulation that only affected the young adults. Surprisingly, overall initial recall was equally high for both groups, but the effect of increasing numbers of categories on recall differed dramatically for younger and older adults. For young subjects the correlation between recall and number of categories was .82, meaning that 67 percent of the variance in recall was accounted for by the number of categories in the sorting scheme. The older subjects, in contrast, recalled the same overall amount as younger adults, seemingly without the benefit of the chunking process provided by increasing the number of sorting categories. This finding shows that older subjects can bring resources to the memory situation that are highly effective, even if mysterious, compared to what is known about young adults. The fact that long-term forgetting was much greater in the elderly, however, suggests that in spite of excellent initial memory, the effects of decay or interference may be more pronounced in the elderly. (KC)

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Aging and the Category-Recall Relationship

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Paper presented at Psychonomics, 1982

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The primary objective of this study was to use a sorting-recall procedure to investigate how long-term memory in elderly subjects is affected by categorical organization.

In the years since Miller (1956) introduced the concept of "chunks," Mandler (1967; Mandler & Pearlstone, 1966) documented the "category-recall" function, showing that young adults will remember an average of roughly four items from every additional category into which they "chunk" the items to be remembered. In a comprehensive set of experiments, Mandler (1967) found a significant linear relationship between the number of categories used in sorting and recall, with a median correlation of .70. The median slope he obtained of 3.9 items is an estimate of "chunk" size because it gives the average number of items retrieved from each additional category into which the items are organized. The intercept gives the estimated number of items subjects would remember in a hypothetical "zero" category condition. Since a non-chunked list would contain "one" category, Mandler (1967) viewed the intercept as "...an estimate of the amount of material recalled on the basis of organizations other than those assessed by the number of categories variable" (p. 350).

The sorting-recall procedure involves presenting all the items to be remembered at once and subjects sort the items into a specified number of groups. The sorting task is repeated until subjects achieve 95% consistency of category assignment on two consecutive sorting trials. In this way,

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subjects are equated on degree of organization prior to recall, rather than on the number of sorting trials or the time of exposure to the stimulus items. This is an important feature when comparing different age groups whose speed of performing the sorting task may differ.

The category-recall relationship has been replicated numerous times with young adults (Mandler, 1967, 1968, Mandler & Pearlstone, 1966) and in our own research with children (Worden, 1974; Worden & Ritchey, 1979), but has not been previously studied in the elderly. Since many investigations have found that old subjects recall significantly less than young adults on free recall tasks (e.g., Hultsch, 1971, 1974, 1975; Laurence, 1967; Mueller, Rankin, & Carlomusto, 1979; Perlmutter, 1978), we wondered whether this commonly found decrement might be due to an aging-related reduction in the "chunk" size in memory.

Based on these previous findings, we expected that overall recall would be lower for the elderly subjects, but it was their category-recall relationship that interested us most. The slope of the category-recall function might turn out to be the same as for young adults, with only the intercept lower. This kind of result would be interpreted to show that the effects of categorical organization on recall are not affected by aging, but rather that extra-organizational capacity is reduced. Conversely, the intercept could be at the same level as for young subjects, but the category-recall slope could be flatter. This result would be interpreted to show that while extra-organizational capacity did not differ, the effect of increased categorical organization was weaker in aged subjects. As it happened, we were surprised to find that none of these predictions turned out exactly as expected.

The young subjects were 32 college undergraduates whose mean age was 20

years. Old subjects were 32 members of a retirement organization associated with the University, and averaged 67 years of age. The retirement club was chosen because its members are roughly comparable to the undergraduate population in terms of geographic area of residency, socio-economic status, health, and education. Old and young subjects were randomly assigned to either the two, four, six, or eight category conditions. Within each condition, subjects were tested on both a high-frequency and a low-frequency list of 48 unrelated words (and task order was counterbalanced). The two levels of word frequency were included as a within-subjects variable because one of our previous studies (Worden & Sherman-Brown, in press), found differing effects for word frequency in young and old adults' memory performance. Finally, we also measured long-term forgetting by giving a second recall of the first list when the main task was finished.

Before the results for recall are presented it is worth noting that neither sorting trials nor sorting time was significantly correlated with recall performance. Clustering was, yielding a correlation of .35, showing that recall was organization-based, rather than, for instance, a function of time of exposure to the items during sorting.

The main analysis for recall was a 2 (age groups) x 4 (category conditioning) a 2 (word frequencies) mixed analysis of variance, with frequency as the within-subjects variable. As predicted, there was a significant main effect of category condition on recall, $F(1,56) = 7.03$. Surprisingly, there was no main effect of age on recall. However, a significant age x category condition interaction showed that the pattern of the category-recall function differed dramatically for old vs. young subjects, $F(3,56) = 4.64$. Figure 1 shows this result. A simple main effects analysis of the age x category interaction showed that while the young subjects' recall

varied significantly as a function of the number of categories in the sorting scheme $F(3,56) = 10.46$, the relationship between number of categories and recall was nonsignificant for old subjects.

For young subjects the three important parameters of Mandler's (1967) category-recall relationship were nicely replicated. The slope of recall as a function of two, four, and six categories for young subjects was 3.67, the intercept was 8.12, and the correlation between the two variables was .82. These were all very similar to median values reported in Mandler's series of studies. In contrast, for old subjects the slope was a virtually flat .52, with an intercept of 20.42 words, and the correlation between number of categories and recall was only .10.

As a secondary finding, word frequency had a large and significant main effect on recall, $F(1,56) = 24.42$. However, the effects of word frequency differed significantly for both recall and clustering as a function of the age of the subjects, $Fs(1,56) = 16.74$, and 7.21, respectively. As Table 1 shows, young subjects recalled and clustered significantly more items with high frequency lists than low, $t(31) = -5.59$, and -2.23, respectively, but word frequency did not affect recall or clustering for the old subjects.

Our other analysis concerned difference scores comparing original with long-term recall. Amount of forgetting was found to be unaffected by either word-frequency or the number of categories into which the stimuli had been originally organized. Age was the only independent variable that contributed to long-term forgetting, $F(1,56) = 12.64$. Old subjects forgot an average of nearly twelve (11.50) words, almost double the 6.00 words forgotten by young subjects. Interestingly, long-term forgetting was not associated with a decay of the initial organizational structure. Analyses of clustering on the long-term recall trial showed that the overall mean value of RRR was a

uniformly high .728, which did not differ for any of the factors.

Returning to the main finding, although the flat category-recall slope for the elderly subjects might suggest a reduced chunk size in memory, the extremely high intercept also suggests the application of extra-organizational resources. We first speculated that the flat category-recall function of the elderly subjects might be due to a tendency to forget whole categories. That is, suppose old subjects had difficulty recalling more than four categories. This would, de facto, produce a flat category-recall function, but this is not what old subjects did. Old and young subjects recalled the same number of categories on average, at each of the four category levels.

The next possibility was that subjects' recall of items within categories differed. Of course, since neither overall recall nor number of categories recalled differed, items per category could not have differed between the two age groups. However, a significant age x categories interaction was found, $F(3,56) = 4.39$. Simple main effects analyses showed that only the two-category condition yielded a significant difference, $F(1,56) = 10.70$. Old subjects recalled 10.12 items per category, which significantly exceeded the 7.62 items recalled by young subjects. The extremely high recall of old subjects of over ten items per category in the two category condition suggests that old subjects may have been forming subcategories out of the two superordinate categories. Thus, the flat category-recall function of the old subjects seemed to stem from unusually good performance in the two-category condition, rather than from particularly poor retention of items when larger numbers of sorting categories were involved.

Let me now summarize various important findings for the old subjects. First, note that their flat category-recall function was not a chance product of a particular set of stimuli, since the results were replicated for two word

lists representing a wide range of word frequency. Second, old subjects did not take a greater amount of time to organize the stimuli overall. Third, old subjects did not ignore the organizational structure created in sorting. Indeed, clustering was uniformly high for the two age groups in the various category conditions, both on the initial task and on the final recall trial as well. Fourth, elderly subjects were not more prone to forget entire categories. Fifth, the surprisingly high intercept of the old subjects suggests that some other means of memorization might have been used in addition to the categories in the sorting scheme.

Thus, the findings strongly suggest that the old subjects were engaged in some kind of highly strategic mnemonic activity in this task. For young subjects the correlation between recall and number of categories of .82 means that 67% of the variance in recall was accounted for by the number of categories in the sorting scheme. The old subjects, in contrast, recalled the same overall amount as young adults, seemingly without the benefit of the chunking process provided by increasing the number of sorting categories! This is remarkable and certainly does not suggest a picture of the elderly individual as having a poor memory because of a decline in the use of active means of organization in recall. Rather, it shows that old subjects can bring resources to the memory situation that are highly effective, even if mysterious, compared to what we know about young adults. The fact that long-term forgetting was much greater, however, suggests that in spite of excellent initial memory, the effects of decay or interference may be more pronounced in the elderly.

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DESIGN

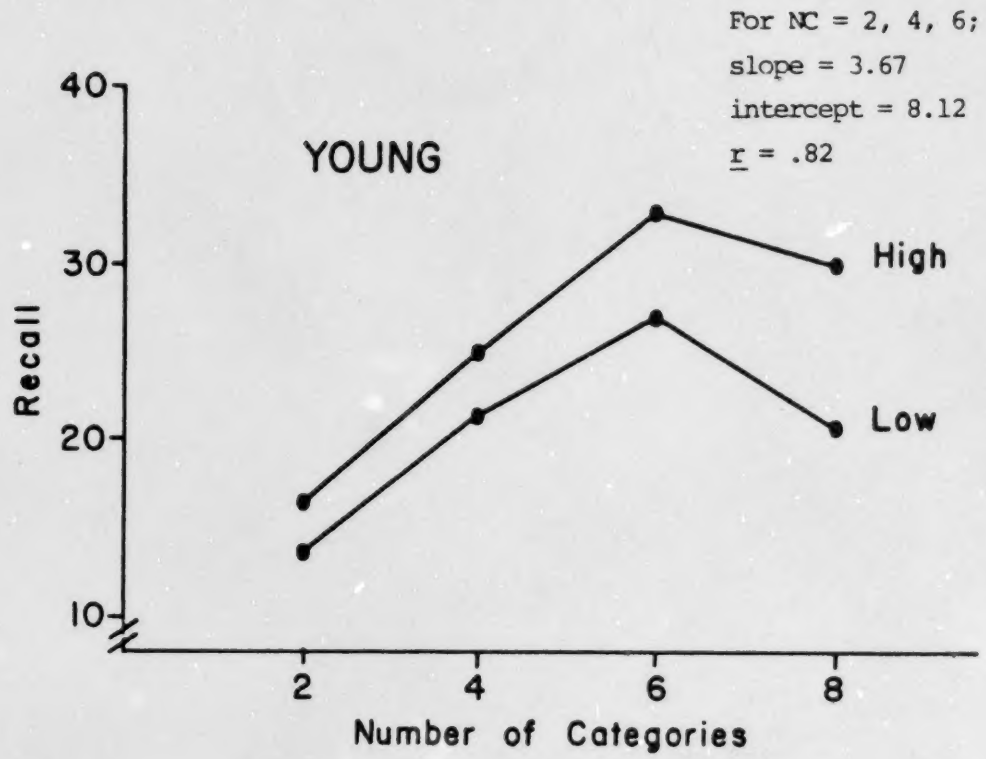
Independent Variables:
- Age (20 vs. 67)
- Number of Categories in the sorting scheme (2, 4, 6, or 8)
- Word Frequency (within-Ss) of 48 unrelated words (high vs. low)

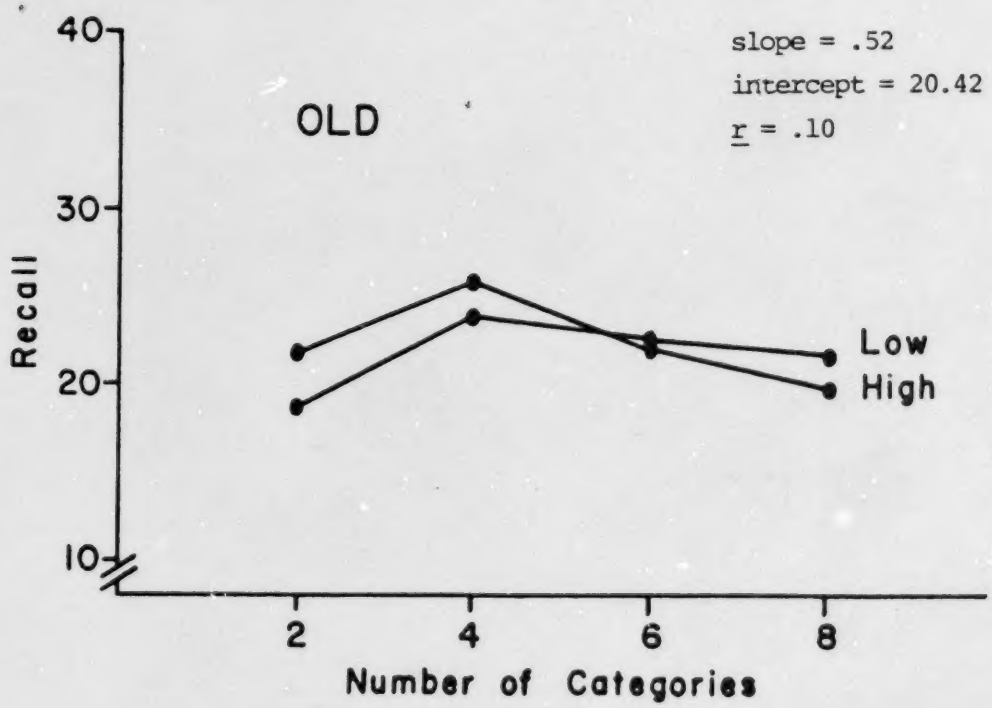
Dependent Variables:
- Recall
- Clustering (Mandler's, 1969, Relative Ratio of Repetition, which varies from 0 to 1.00)

Table 1

Recall and Clustering as a Function of Age and Word Frequency

	High Frequency		Low Frequency		Mean	
	Recall	Clustering	Recall	Clustering	Recall	Clustering
Young	26.16	.83	20.84	.75	23.50	.79
Old	22.25	.71	21.78	.77	22.03	.74
Mean	24.22	.77	21.29	.76	22.76	.76


For NC = 2, 4, 6;
slope = 3.67
intercept = 8.12
r = .82
YOUNG
High
Low
Recall
40
30
20
10
2
4
6
8
Number of Categories


slope = .52
intercept = 20.42
r = .10
OLD
Low
High
Recall
40
30
20
10
2
4
6
8
Number of Categories